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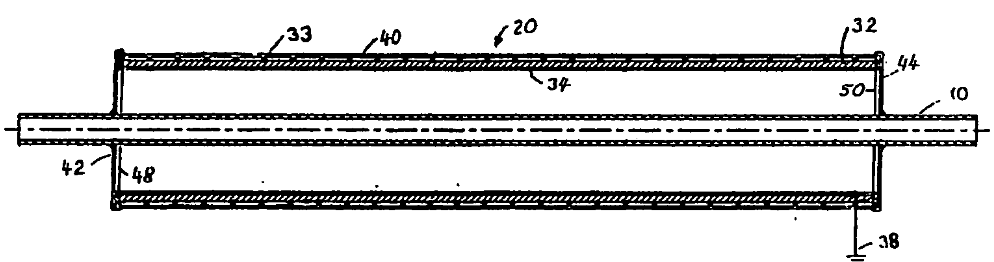
(54) Title: BURNER FUEL LINE ENHANCEMENT DEVICE



(57) Abstract

An insulated coil (20) of wire (23) of a prescribed length and number of turns is positioned to surround a linearly-extending portion of a metal or plastic fuel conduit (10) associated with an internal combustion engine or conduit transporting a burner gas to a stove burner or furnace. The coil core (22) may be electrically conductive wire which is surrounded by electrical insulation or liquid electrolyte (31) contained in plastic tubing (30) which tubing is coiled around the fuel conduit (10). The coil is substantially coaxial to the conduit and is earthed. The use of the device is shown to increase the miles per gallon of fuel performance of an auto and to improve combustion emissions. In gas burner applications, the number of days of use from a standard volume gas cylindre has been substantially increased when the device is used.

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Burner Fuel Line Enhancement Device

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a device for improving the performance characteristics of particulate materials and fluids, including liquid fuels such as gasoline and burner cooking or heating gas.

Related Art

Internal combustion engines have employed various devices such as catalysts and heating devices for enhancing hydrocarbons being employed as the engine fuel. Heating coils 22 have been used in catalyst beds as seen in U.S. Patent 3,639,200 for conversion of a fuel and regeneration of the catalyst. U.S. Patent 3, 928,155 shows coagulation of particles in liquid flowing through a supply conduit where a self-induced e.m.f. uses the liquid as an electrolyte to cause changes in ion charge to form nuclei initiating precipitation of particles. This is done by providing coiled and twisted wires in a stainless steel tube to aid in prevention of scale and corrosion. U.S. Patent 3,116,726 shows an inductance coil surrounding an I.C. engine fuel line between a fuel pump and carburetor which coil is electrically connected to a high-tension ignition system so that the fuel line is subjected to a high intensity magnetic field serving to improve the "hotness" of the spark within the engine cylinders. U.S. Patent 4,073,273 discloses the application of an electrostatic field in an I.C. fuel line to improve anti-knocking and increase available energy for engine operation. Insulated metallic barrels are employed around a fuel line. An electrical circuit provides an intense electrostatic field. Electromagnetic coils are found in

U.S. Patent 4,381,754 which surround an I.C. engine fuel line causing a magnetic flux field resulting in increased fuel efficiency. U.S. Patent 4,755,288 uses a magnetic field generator to increasing the energy in the fuel flowing through an I.C. engine fuel line. Electromagnetic coils connected to a battery are utilized around a fuel line in U.S. Patent 3,989,017. An energy efficiency system is seen in U.S. Patent 4,074,670 where a pair of (bare) coil windings having parallel axes are provided in a unit casing with iron cores positioned interiorly of the coils with the ends of the coils interconnected by leads. The unit is attached to the top of the fuel line by a few turns of wires 36 which function only to hold the unit in place.

A prior invention of applicant (US Ser.No. 647330, now US patent 5 134 985 provides a multi-turn insulated coil of wire which surrounds the fuel-carrying conduit. The two opposite terminals of the coil are short-circuited by any suitable means such as by joining through a connector, brazing, soldering, or by other means. The coil may also be wound directly around the conduit or pipe carrying the fluid. Alternatively, the coil may be wound on a cylindrical or split plastic form which can be slipped over the pipe, conduit or conductor. The coil also may be in the form of a molded insert which can be fitted in a pipe, conduit or conductor and used as a connecting piece between separate conduits or pipes.

The performance characteristics of particles and fluids in conduits or pipes have been found to improve if said coils are fitted around the conduits or pipes. The invention relates to a device for improving the flow and performance characteristics of particles and fluids including liquids such as gasoline used in internal combustion engines, or of fuel gas used in cooking or

heating in stoves or furnaces. The insulated coil is of predetermiend diameter and length, made by winding a predetermined number of turns of an insulated electrical conducting wire of predetermined cross-section on a fuel conduit, or made of wire contained in a hollow form of an electrical insulator placed around the conduit. In another embodiment, a plastic tube of hollow cylindrical form may be filled with an electrolyte with the tube then coiled around the fuel line. In another embodiment, the coil may be bare wire turns wound about an insulative plastic fuel conduit so that each turn is spaced from an adjacent turn and the overall coil then covered by wound layers of tape insulation. In each case the two opposite terminals of the coil are short-circuited in a predetermined manner.

SUMMARY OF THE INVENTION

Meanwhile performed experiments have shown that the efficiency of the device according to the aforesaid prior invention of applicant may be additionally improved.

According to the present invention, this is achievable by the further feature that the said short-circuited coil is substantially coaxial to the fuel line and is earthed.

A still further improvement is achievable if a conductive sleeve sorrounds the said coaxial and earthed coil on at least a portion of its length and is conductively connected to the coil. Additionally, or alternatively, to said outer sleeve, there may be provided a conductive sleeve inside the said coil along at least a portion of the coil length. Said inner sleeve is however nowhere connected, but is electrically floating.

As has been found further, the device according to the invention functions, in effect, as a microwave resonator

circuit being tuned to about the X band (about 8 to 12.5 GHz). As has been found in this connection, each of the aforesaid measurements, namely earthing the short-circuited coil and adding the electrically floating inner conductive sleeve and/or the outer conductive sleeve connected to the coil, is contributive to a further improvement of the device according to the invention.

Usable microwave energy comes both from natural sources and from artificial sources, for instance communication satellites. One example for a natural microwave radiation source is the cosmic background radiation which corresponds to the radiation of a black body at a temperature of about 2,7° K and is centered at wavelengths of about 3 to 12 cm.

Apparently, it is this microwave energy which is coupled into the fuel carrying conduit and acts upon the fuel in the sense of an improvement of the efficiency of the subsequent combustion. A possible explanation of this phenomenon, however without limitation thereto, is the following.

As known in non-equilibrium situations or in equilibrium situations during or near a phase transition there may occur phenomenons like the Bénard instability or the Belousov-Zhabotinsky reaction as a consequence of a very weak external field, the value thereof is several million times weaker than the gravity in case of electrical fields. Such external fields may cause a spontaneous self-organization of the system. In certain cases, the system can form new structures which are stable (Markov-process) - see Physica 107 A (1981) 1 - 24, North-Holland Publishing Co. . Apparently, it is those re-orderings in structure within the fuel which finally leads to the observed improved combustion efficiency.

In order to avoid negative perturbations by electromagnetic energy of frequencies other than the desired ones the fluid conduit, if not made of metal, should be preferrably shielded (and earthed).

With a view toward the directionality of a helix antenna, it is preferred, during operation, to direct the device according to the invention toward the aforesaid microwave energy sources, that is to say a substantially vertical orientation. In this context, it is also favorable still to add reflecting means below the device such that the latter is substantially in the focus of the reflecting means.

In view of a possibly still required adaptation to the particular fuel it is recommendable to add a capacitive tuning member. Advantageously, this is realized by a metallic plate disposed adjacent to at least one end surface of the coil, which plate is supported by the fuel line.

Preferrably, this plate is disposed movably along the fuel line.

In case of large fuel conduit cross sections, it is in particular advantageous, to add an associated microwave transmitting means being arranged such that at least one of its main lobes is directed onto the inventive device. Alternatively, a microwave generator means may be provided the output of which is coupled to the inventive device.

In case of a metallic fluid conduit still further improvements are achievable by an outer shielding which surrounds the fluid conduit and is separated therefrom by an airgap. Said outer shielding may be realized in any way, for instance made from metal, metallized plastics or metal foil covered plastic tubes, etc. . Said outer shield may be earthed, too.

BRIEF DESCRIPTION OF THE DRAWING

The invention is further described with reference to the accompanying drawings, in which:

Figure 1 is a schematic side view of the device according to applicant's prior invention showing an insulated coil wound as a right-hand helix in the direction of fluid flow in a conductive conduit;

Figure 2 is a schematic side view of the device according to applicant's prior invention showing an insulated coil wound as a left-hand helix in the direction of fluid flow in a conductive conduit;

Figure 3 is a cross-sectional perspective view of the insulated coil-forming wire according to applicant's prior invention;

Figure 4 is a cross-sectional perspective view of a second embodiment of the wire according to applicant's prior invention;

Figure 5 is a cut-away perspective view of a third embodiment of the wire according to applicant's prior invention;

Figure 6 is an end view of a fourth embodiment of the coil according to applicant's prior invention;

Figure 7 shows a pair of separate shorted coils on a conduit according to applicant's prior invention;

Figure 8 is a schematic longitudinal-sectional view of a first embodiment of the present invention;

Figure 9 is a schematic cut-away longitudinal-sectional view of a second embodiment of the present invention.

DETAILED DESCRIPTION

Figure 1 shows a fuel line 10 for transporting fuel to an internal combustion (I.C.) engine (not shown) or a household or other burner (not shown) such as a gas stove for cooking or a heating unit. The conduit can be made of a conductive material such as copper or aluminum tubing or of plastic material.

A coil 20 of wire 23 is wound about the conduit. The helix angle at which the electrical conducting wire 23 in Figures 1 and 2 is wound and the number of turns of the resultant coil are varied depending on the extent of improvement of the said flow characteristics desired. The helix angle typically will be from 5° to 45° from the coil longitudinal axis. The preferred number of turns is between 26 and 30 turns extending over an incremental length of the fuel conduit, the length being dependent on the conduit OD and the insulated wire OD. Preferably still the number of turns is 28. Tests were made with as few as five turns and as many as 40 turns but the results were not those sought. Optimum and useful results appeared to be achieved in the 26-30 turn range. The diameter or cross-section of the conduit 10 is determined by the quantity and quality of the fluids to be handled. The diameter or cross-section of wire 23 also depends on the extent of improvement of the fuel characteristics desired to be attained by using the device. In Figure 1 a right-hand coil lay is employed while in Figure 2 a left-hand coil lay is seen. The coils normally abut each other so that there is no spacing between the adjacent coils of insulated wire. When bare wire is used on plastic conduit, the adjacent coils of wire are spaced from each other so as not to short circuit directly.

The coil is wound on conduit/pipe, which may be a steel or other metallic pipe or a plastic pipe which is designed for the particular fuel (liquid or gas) being

conveyed through the pipe. The wire 23 includes a conductor core 22 covered with an insulating material 21 as seen in Figure 3. The insulating material may, for example, be polyvinyl chloride, polyethylene or natural or synthetic rubber. Alternatively, the conduit/pipe may be covered as seen in Figure 4 with a cylindrical shell of an insulating material 30 over an incremental or greater length of the tubing with a coil 20a of wire embedded in the shell. The two opposite terminals 11 and 12 of the coil are short-circuited at position 14 by welding, soldering, brazing or by a conventional mechanical connection 16 such as an alligator clip or twist connector. In Figures 1 and 2 flow of the liquid fuel or gaseous fuel is in the direction shown by arrow 15. In a third embodiment shown in Fig. 5, the coil is formed in the form of hollow flexible tubing 30 of polyvinyl chloride or other plastic. The hollow structure of the tubing contains a liquid conductive electrolyte 31, such a sodium chloride or potassium chloride in an aqueous solution. The tubing is then wound around the fuel conduit in the necessary number of turns and the ends of the tubing including the electrolyte connected by a coupling so that each end of the tubing is short-circuited with the other i.e. the electrolytic solution extends through the entire fuel conduit-surrounding coil.

Typical examples of the application of the novel device are presented below:

<u>Example I</u>

Emission tests were carried out on the exhaust gases from a Fiat 1100 cc. auto by the Indian Institute of Technology in Madras, India. The tests were carried at idling speed about (450-500 RPM) on a stationary car. The analyzer used was a portable Horiba (Japan) HC/CO analyzer.

HC -- Hydrocarbon

CO -- Carbon Monoxide

Results were as follows:

<u>Without Device</u>

<u>HC/PPM</u>	<u>CO</u>
790-810	3.8-3.93

<u>With Device</u>

<u>HC/PPM</u>	<u>CO</u>
740-750	3.75-3.95

A difference of 50 PPM in HC emissions, i.e. about 6% improvement was obtained.

<u>Example II</u>

A Menlo Park, Ca. test was carried out at idling on an American car without a catalytic converter. An engine analyzer was used.

Emissions Readings (<u>Without Device</u>)

HC:	215 ppm	CO:	1.82%
CO_2:	11.9 %	O_2:	2.9 %

917 RPM

Emissions Readings (<u>With Device</u>)

HC:	199 ppm	CO:	1.41%
CO_2:	12.1%	O_2:	2.9 %

920 RPM

The results were printed out at approximately the same engine idling R.P.M.

A difference of HC emissions of about 6% was obtained. A significant reduction in CO, about 20%, was obtained unlike the Indian results. A possible explanation for the variation in the absolute values of the tests between the Indian and U.S. results could be as follows:

a) Leaded petrol is used in India as a fuel, unlike the U.S.A.

b) The relative humidity in Madras, India is of the

order of 85%, unlike Menlo Park which is much drier.

Example III

Mileage Test, India, Madras.

A Kawasaki Bajaj 100 cc. motorbike was used. A test ride circuit on relatively traffic-free city roads was used. The speed maintained was between 40-50 kmph.

The test procedure was as follows. Half a liter of petrol was poured into an empty fuel tank each time. The motorbike was operated on the chosen circuit until the fuel tank was empty. Kilometer readings were noticed from the speedometer at the beginning and end of each run.

The kilometers travelled were as follows:

Without Device		With Device
Run	Kilometers Travelled	
1)	27 kms	31 kms
2)	31 kms	34 kms
3)	30 kms	37 kms

Discarding run no. 3, an average increase of about 10% was obtained.

Example IV

U.S.A., Menlo Park, CA to San Jose, CA

A fuel injection Oldsmobile with an onboard mileage computer was used. The car was driven each time on a flat stretch of about 10 miles on the six-lane 101 Highway between Menlo Park and San Jose, once at 50 MPH, and then at 55 MPH in non-rush hour light traffic.

The onboard computer was set to give instantaneous miles per gallon (IMPG) readings. The test results were done once with and once without the device.

No appreciable difference could be noticed between the tests at 50 MPH and 55 MPH. There was hardly any wind observed.

Without Device I.M.P.G.	With Device I.M.P.G.
27-40	32-43

Here the device was mounted on the fuel pipes in situ, i.e. 28 turns of insulated wire (Indo Cables 23 strand copper wire) were wound directly on two metal fuel pipes (about 3/8" O.D.) leading to engine cylinder injectors. Three layers of black insulating tape (electricians) was wound about the coil and the short-circuit connection of the coil ends.

The driver reported that he found it easier to maintain a constant speed with the device than without the device. The above results would also indicate a savings in fuel though the wire length and number of coils used was not optimized for this size of engine and was the same as used in the device described above for engines from 50 cc. to 1.1 liter and normal household gas stoves (Indians commonly use two-burner stoves.)

General Results

An improvement in engine torque at low engine RPM has been noticed when driving a car fitted with the device by several drivers, both in India and the U.S.A.

Starting from a cold start condition is also improved. Hence battery life should be improved.

No deterioration in performance of the cars and mopeds fitted with the device over several months of testing has been noticed. Essentially the improvement in performance of the vehicle fitted with the device appears to remain constant.

The only deleterious effect noticed so far in India is that exhaust tailpipe corrosion is considerably accelerated. However, it should be noted that exhaust tailpipes of Indian cars are made of ordinary steel and not of stainless steel. This would also indicate that exhaust tailpipe temperature is lower with the device

fitted.

Example V

Gas Stoves/Madras, India

Three families were selected from different backgrounds and different income levels. These people had also kept reasonable records of how long a cylinder of cooking gas would last, usually between 28 to 35 days. The figure was, however, substantially constant for each household.

The device was fitted onto the fuel pipe from the gas cylinder to the stove and they were asked to keep records of how long the cylinder lasted. Cylinders are supplied in India by the government-owned oil company. About five months of observation are available. An increase in the number of days a cylinder of gas would last was obtained by all three families. The increase was between 10 to 15%. The experiment is still going on. These results would indicate that no external electrical field is necessary. The families have reported that the burners have a bluer flame when the device is incorporated on the fuel line than they have seen from the prior fuel line without the coil device installed.

A typical device as used on fuel pipes of engines between 50 cc. to 1.1 liter and on the gas pipe of household gas stoves uses a former of ordinary household PVC piping (5/8" I.D., 3 1/2" long). Two holes of 3/8" diameter are drilled, one on each end of the pipe about 1/4" from the edges. The purpose of the holes is to anchor the coil to the former. The cable used is Indian specification Indo Cables copper multistrand wire with 23 strands. Diameter of the wire was 0.006 inch. Outer insulation is PVC or other plastic. A right-hand coil of 28 turns is tightly wound on the former with no spacing between the abutting turns. The ends of the coil pass

through the holes in the pipe former and are connected by a banana jack and socket so that the coil can be quickly short-circuited. The coil is then wrapped with three layers of black insulation tape. Alternatively the coil ends may be twisted together or metallurgically bonded by soldering, brazing or welding.

The former is slipped on to the fuel pipe leading to the carburetor or onto the gas fuel pipe leading to the stove. When the coil is short-circuited, it is operative. As seen in Fig. 6, two half cylindrical shells 17 and 18 of PVC may be placed on the top and bottom of the fuel line 10 and bare or insulated wire 25 wound around the two half shells. The outer surface of the wound unit can then be covered by insulating tape 27 and the ends 26 of the coil interconnected.

Other suitable applications of the invented device with beneficial effects may be as follows, although tests have not been made to date.

1. On the inlet pipe to the air filter, on the wire from the magneto to the spark plugs and on the exhaust pipe of an I.C. engine in a motor car;

2. On all the pipes carrying inlet streams to a reactor and on all the pipes carrying outlet streams from a reactor;

3. On the inlet stream pipes carrying oil, gas, coal dust, etc. to a boiler or gas producer;

The invented device also may be constructed by utilizing a plurality of coils spaced on the fuel conduit as seen in Fig. 7 where the coil 20 are spaced on fuel conduit 10 and each separately short-circuited.

Figure 8 shows an embodiment of the present invention which differs from the above described embodiments in some essential features.

Here, the coil 20 is formed by the turns of a wire 33 which is wound around an insulating tube 32 in the required number of turns, preferrably with 28 or 28 1/4 turns. The interior of the insulating tube 32 is lined with a metal sleeve 34, for instance of copper or aluminum. The two ends of the coils 20 are short-circuited (not shown), and earthed, as shown at 38. The sleeve 34 is nowhere connected and electrically floating. An insulating layer 40 is still attached around the coil 20, which consists in this case of bare wire. The whole structure surrounds a metallic fuel conduit piece 10 and is held in position by means of two disk-like plates 22, 44, at the end faces of the coil structure. The plates 42, 44 consist of copper or another metal and are suitably fixed at the conduit 10. The plates 42, 44 are insulated by insulating rings 48 and 50 relative to the coil structure and its conductive sleeve 34. It is not necessary that the sleeve extends along the whole length of the coil.

As already mentioned, further investigations have shown that the coil acts as a helix antenna for electromagnetic waves in the centimeter region (about 8 to 12.5 GHz) and it is in effect the coupling of the received microwave

energy into the liquid or the gas within the conduit 10 which eventually causes the observed phenomenon. The earthing of the coil and the addition of the conductive sleeve 34 increase each the antenna gain. The insulating sleeve 32 acts as a cavity resonator. Therefore, the two end plates 22 and 24 may also be understood as capacity components of the whole resonator circuit, which components permit, for instance by distance variation, a tuning. In such a case, the conductive end plates 42 and 44 are attached to the pipe 10 in a length-movable manner, and the coil structure 20 is otherwise suitably fixed to be coaxial to the pipe 10.

Figure 9 shows a modified form of the embodiment according to Figure 8. This Figure shows only the electrically effective parts of the resonator circuit; the conduit and the needed bodies for fixing and insulating the several portions are omitted.

The coil 20 may be wound of bare or, as shown, of insulated wire 52. Its turn number is 27 or 27 1/4. The coil is located within a first conductive sleeve 54 and is short-circuited through this sleeve and is earthed as shown at 36 and 38.

Additionally, there is a further conductive sleeve 56 inside the coil. The sleeve 56 is nowhere connected, that is to say it is electrically floating. The inner conductive sleeve 56 serves to increase the Q value of the resonator circuit. It is equivalent to the sleeve 34 of Figure 8.

Additionally, at least one of the end plates 42, 44 of Figure 8 may also be provided in the embodiment according to Figure 9.

It is still to be remarked that the end plates 42, 44 may be varied in their radial extension for tuning purposes.

The decision, whether the inventive device is used together with a fuel conduit of metal or of plastic (or another di-electricum), or whether the fuel conduit is of metal only in the region of the coil, but is otherwise of plastics, and vice versa, is a question of optimizing which may be cleared by simple tests in a particular case. This is also true for the choice of the used plastics or other dielectrica, in particular in view of the dielectric constants thereof, as well as for the remaining parameters, in particular the number of coil turns, and for the question of shielding a fuel conduit.

The expression "wire" as used in this specification is to be understood in its most general meaning and shall designate any conductor form, for example, also a metallized plastic tape.

CLAIMS:

1. A device for improving the performance characteristics of particulate material and fluids flowing through a conduit, in particular a fuel conduit, comprising:

at least one coil of predetermined diameter and length and of a predetermined number of turns, said coil comprising an electrical conductor core and electrical insulation therearound and being coiled around a length of said fuel conduit, the ends of said conductor being electrically connected so as to form a short circuit, wherein said short-circuited coil is substantially coaxial to the said conduit and is earthed.

2. The device according to claim 1 wherein a conductive sleeve surrounds the coil on at least a portion of its length and is conductively connected to the coil.

3. The device according to claim 1 or 2 wherein an electrically floating conductive sleeve is disposed inside said short-circuited coil and extends along at least a portion of the coil length.

4. The device according to claim 2 in which the number of turns of the coil is about 27 or 27 1/4.

5. The device according to anyone of claims 1 to 4, wherein, in operation, the coil is vertically oriented.

6. The device according to anyone of claims 1 to 5, which, in operation, is exposed to incoming microwave energy of approximately the X band region (about 8 to 12.5 GHz).

7. The device according to claim 6, wherein the microwave energy is from natural sources or from satellites.

8. The device according to claim 5 to 7, wherein a reflector arrangement is disposed below the device such that the device is substantially in the focus of the reflector arrangement.

9. The device according to claim 5 or 6, wherein the microwave energy is from an associated microwave transmitter means disposed such that at least one main lobe thereof is directed to the device, or is from a microwave generator means the output thereof being coupled to the device.

10. The device according to anyone of claims 1 to 9, wherein said conduit is additionally shielded.

11. The device according to anyone of claims 2 to 10, in which the coil on at least one of its end faces is adjacent to a metallic plate which, in turn, is disposed on the conduit.

12. The device according to claim 11, in which the plate is movably disposed along the conduit.

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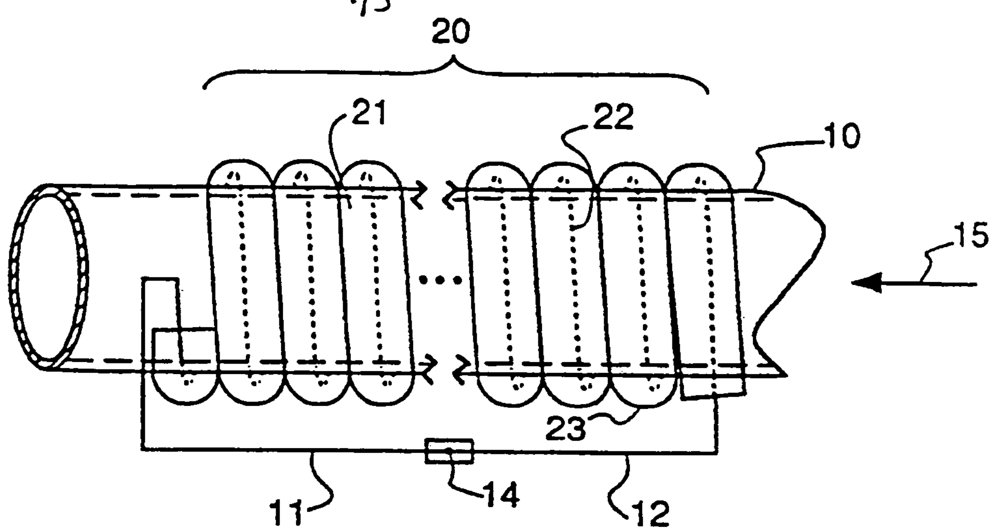

FIG. 1

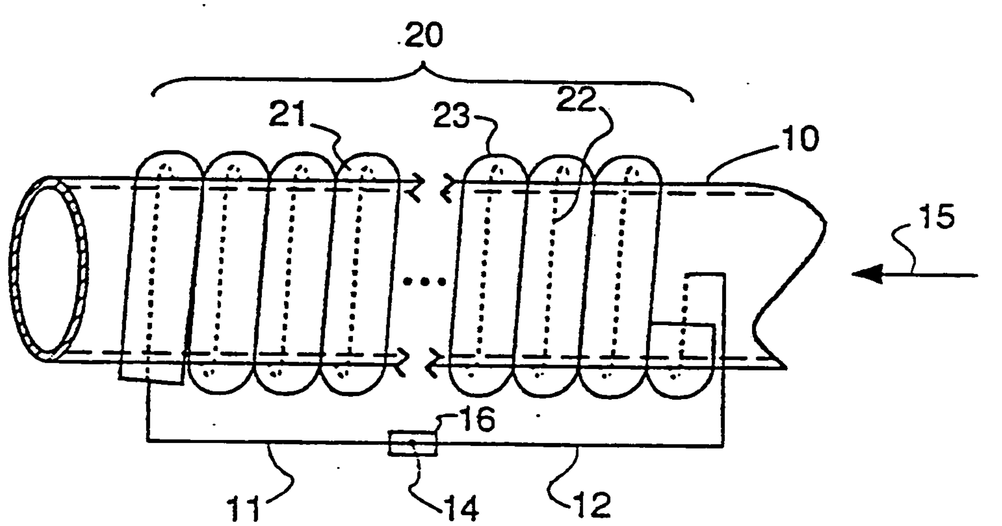

FIG. 2

2/3

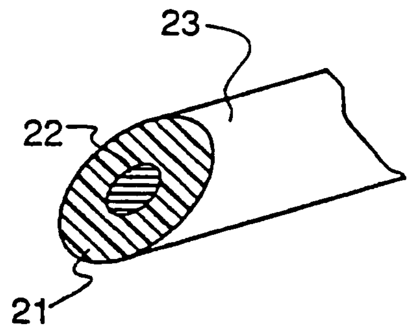

FIG. 3

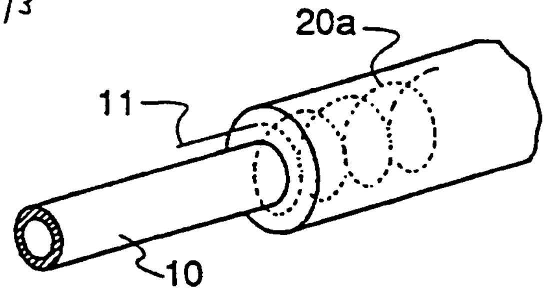

FIG. 4

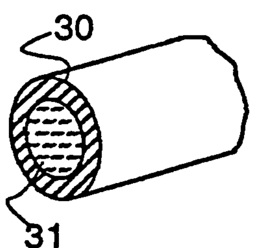

FIG. 5

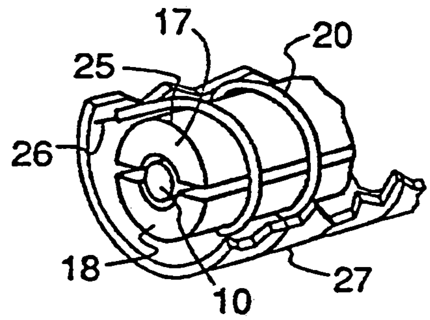

FIG. 6

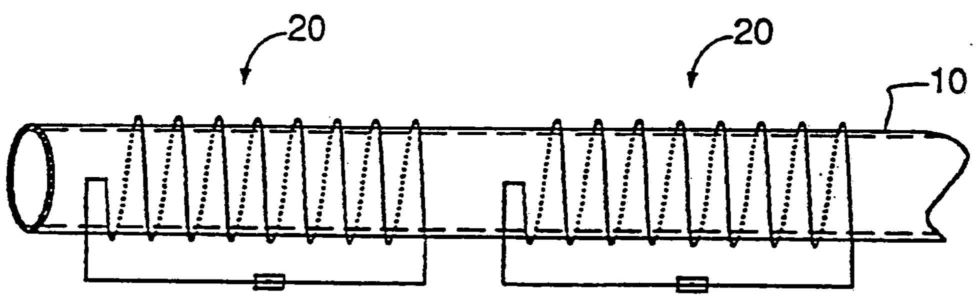

FIG. 7

3/3

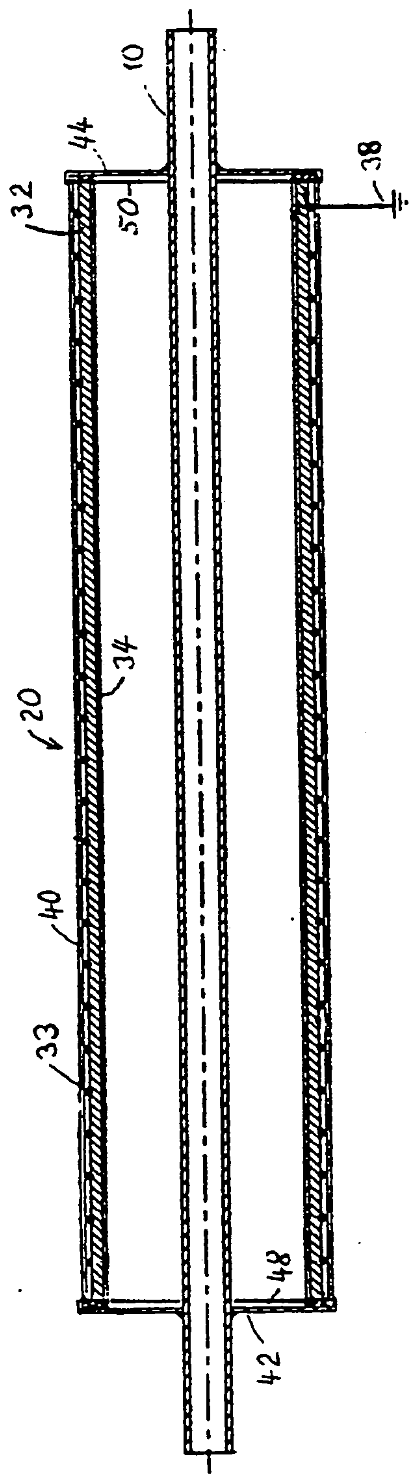

FIG. 8

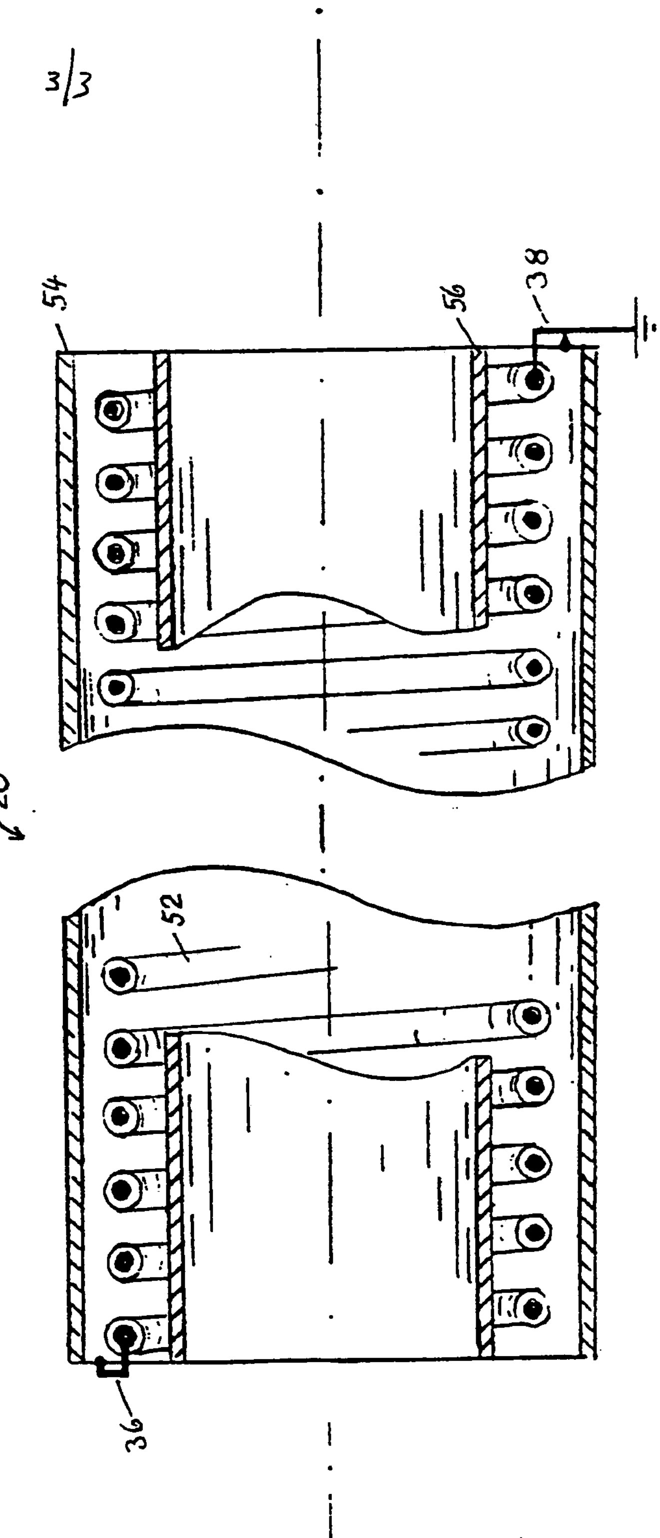

FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 93/00057

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F02M27/04; F23K5/08; B01J19/08

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F02M ; F23K ; B01J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
A	DE,B,1 037 765 (ROBERTO MELI) 28 August 1958 see column 1, line 8 - line 22 see column 2, line 52 - column 4, line 6; figures 1-4 ---	1-3, 10-12
A	US,A,3 976 726 (JOHNSON) 24 August 1976 see column 1, line 33 - line 60 see column 4, line 16 - column 5, line 42; figure 3 ---	1,2,10, 11
A	US,A,3 989 017 (REECE) 2 November 1976 cited in the application see column 2, line 14 - column 4, line 6; figures 1,3,13,15 --- -/--	1-3

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12 MAY 1993	19.05.93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	VAN ZOEST A.P.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4 074 670 (ROBERTS) 21 February 1978 cited in the application see column 2, line 7 - line 63; figures 1,2,5	1

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

EP 9300057
SA 69051

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 12/05/93
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-B-1037765		None	
US-A-3976726	24-08-76	CA-A- 1030026	25-04-78
		JP-C- 996514	20-05-80
		JP-A- 50132539	20-10-75
		JP-B- 54030055	27-09-79
US-A-3989017	02-11-76	None	
US-A-4074670	21-02-78	US-A- 4158346	19-06-79

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82